ISSN 1995-0802, Lobachevskii Journal of Mathematics, 2017, Vol. 38, No. 5, pp. 843–848. © Pleiades Publishing, Ltd., 2017.

The Use of Ann for the Prediction of the Modified Relative Permeability Functions in Stratified Reservoirs

K. Potashev*

(Submitted by A. M. Elizarov)

Kazan (Volga Region) Federal University,
N.I. Lobachevsky Institute of Mathematics and Mechanics, Kazan, 420008 Russia

Received September 29, 2016

Abstract—The paper presents a method of instantaneous construction of relative permeability pseudo functions in analytical form upscaled to a coarser computational grid using a system of artificial neural networks. The coefficients of these functions can be forecasted by the neural network. The learning dataset is based on a preliminary series of calculations at the reference values of the system parameters the exponents of the initial functions, the liquid phases viscosity ratio, the statistical parameters of distribution laws of the reservoir's properties. The latter may be obtained according to the primary well logging data with no need for building a detailed geological model.

DOI: 10.1134/S1995080217050286

Keywords and phrases: *Two-phase flow in porous media, relative phase permeability, upscaling, pseudofunctions, artificial neural network, stratified petroleum reservoir.*

1. INTRODUCTION

Optimization of oil field development requires a large number of multivariate solutions of two phase flow problem. For large reservoirs where traditional computational grids contain tens or hundreds of millions of blocks, such tasks becomes practically impossible. Reducing of computational cost can be achieved through the computational grid coarsening with upscaling procedure for the reservoir properties.

It is known that for upscaling of relative permeability (RP) functions the most reliable methods are those of building dynamic pseudo functions (pseudos) [1]. However, this requires the solution of unsteady multi-phase flow problems on detailed computational grids reflecting the geological structure of the reservoir, generally in each block of the coarse grid. And the computational cost required for this procedure can be comparable to the cost of the direct reservoir simulation on the original detailed grid. To overcome such difficulties, one or several of the following approaches can be used: i) solving the upscaling problem for a small number of coarse blocks, which are typical of the areas of various geological structure; ii) reducing the dimension of the problems solved on a fine grid by assumptions concerning the local flow symmetry; iii) representing the pseudos as functional dependencies, whose coefficients are calculated according to the geological parameters of the reservoir without a numeric simulation of the unsteady two phase flow on a fine grid.

This paper demonstrates the possibility of instantaneous definition of the coefficients of modified relative permeability (MRP) functions to describe two-phase flow in a thickness-averaged stratified reservoir for a wide range of parameter values, which characterize distribution of the porosity, absolute permeability and thickness of the layers, the form of the initial RP, and the liquid phase viscosity ratio. A series of upscaling problems is preliminarily solved for the reference combinations of input parameters of the reservoir and fluids with calculation of the coefficients of MRP dependencies. Using the obtained

*E-mail: kpotashev@mail.ru